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Publication date:
2015

Document Version
Peer reviewed version

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Citation (APA):

Chen, Y., Trier, F., Christensen, D. V., Linderoth, S., & Pryds, N. (2015). *Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces*. Abstract from TO-BE Spring Meeting 2015, Aveiro, Portugal.

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Charge transfer induced modulation doping of two-dimensional electron gas at complex oxide interfaces

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The discovery of two-dimensional electron gases (2DEGs) at the interface between two insulating complex oxides, such as LaAlO_3 (LAO) or $\gamma\text{-Al}_2\text{O}_3$ (GAO) epitaxially grown on SrTiO_3 (STO)^{1,2}, provides an opportunity for developing all-oxide electronic devices^{3,4}. However, large enhancement of the interfacial electron mobility remains a major and long-standing challenge for fundamental as well as applied research of complex oxides. Here, we report a 2DEG mobility enhancement of more than two orders of magnitude obtained by inserting a single unit cell (uc) buffer layer at the interface between disordered LaAlO_3 and crystalline SrTiO_3 created at room temperature.⁵ The spacer layer suppresses strongly the formation of oxygen vacancies on the SrTiO_3 side and leads to an unexpected modulation-doping scheme of the complex oxide 2DEG via interface charge transfer.⁶ This results in a very high 2DEG mobility exceeding $70\,000\text{ cm}^2\text{V}^{-1}\text{s}^{-1}$ at 2 K and low carrier density in the range of 10^{12} cm^{-2} . These findings open new avenues for oxide electronics.

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